REMARKS

Claims 6, 7, 11-13, 15, 20, 21, 24, 25 and 31-45 have been canceled, claims 1, 4, 5, 8, 9, 16, 18, 19, 22 and 26-30 have been amended and claims 46-57 have been newly added by amendment. Claims 1-5, 8-10, 16-19, 22, 23, 26-30 and 46-57 are currently pending in the application.

Amendments to the Specification

The specification has been amended to address concerns raised by the Examiner regarding numerical identifiers that appear in the figures, but which are not mentioned in the specification.

With respect to element 204 shown in Figures 4A and 4B, the specification has been amended to have label 204 refer solely to a microchannel, thereby relieving the objection raised by the Examiner.

The reference label 466 in paragraph [0097] has been removed.

With respect to element 511 in Figure 5, the specification has been amended to include reference to element 511.

With respect to elements 480 and 482 in Figure 6D, the specification has been amended to include reference to these elements.

With respect to elements 604 and 608 in Figure 8, the specification has been amended to include reference to these elements.

With respect to elements 100 and 101 in Figure 9, the specification has been amended to include reference to these elements.

With respect to elements 800 and 820 in Figure 18, the specification has been amended to include reference to these elements.

With respect to element 880 in Figure 22A, the specification has been amended to include reference to element 880.

With respect to Figure 12A, reference to this figure was inadvertently left out of the discussion beginning on page 31, paragraph [0110], comparing the results illustrated in Figures 12A and 12B. The subject of this comparison is clearly stated in the Brief Description of the Drawings, on pages 11-12, paragraphs 0025 and 0026. By amendment to the specification a reference to Figure 12A is now included.

Basis for the amendments to the specification are summarized in the table:

Amendment	Basis
Page 23, para. [0079]	Page 26, para. [0092] provides the governing description.
Page 27, para. [0096]	Description of illustration of Figure 5.
Page 28, para. [0097]	Deleted reference to unlabeled component of the figure
Page 28, para. [0098]	Description of illustration of Figure 6D.
Page 29, para. [0100]	Description of illustration of Figure 8.
Page 29, para. [0101]	Description of illustration of Figure 9.
Page 31, para. [0110]	Page 11, paragraph [0025].
Page 38, para. [0142]	Description of illustration of Figure 18.
Page 39, para. [0146]	Typographic correction.
Page 40, para. [0148]	Description of illustration of Figure22A.

Amendments to the Claims

The claims have been amended to focus on the aspect of the subject invention related to the reduction of bubble formation at electrodes in fluidic devices by the use of silver/silver chloride-based conductive inks.

The amended and new claims generally track the original claims, with changes entered to more precisely claim as the invention microfluidic devices having silver/silver chloride-based electrodes and methods for improved electrokinetic applications using the same.

Specific basis for terms used in the amended and new claims are as follows:

Claim	Term/Phrase	Basis
1, 26, 46	a driving electrode	Page 8, [0007], line 3; Page 10, [0017], line 3; Page 11 [0021] lines 2, 3; Page 12 [0032], line 2; Page 18, [0063], line 1; Page 27, [0093], lin 12.
1,	silver/silver chloride ink	Original claim 16, 17.
5	using an adhesive	Original claim 6.
5	using a double-sided adhesive layer	Original claim 7.
10	screen printing	Original claim 11.
10	lithography	Original claim 12.
17, 30	a polyester-based silver/silver chloride ink	Original claim 16 and 29.
18	ink pattern	Original claim 19
19	includes a contact and a lead	for example, Figures 5, 6A.
22	consisting of...	Proper Markush notation.
26	providing at least two driving electrodes for contacting a medium in the channels and reservoirs	Page 30, [0106]; Page 37, [0135].
26, 46	at least one driving electrode	Page 21, [0073].

	has a surface comprising silver and silver chloride	
26	such that fewer bubbles form in said channels and reservoir as are formed when applying said voltage across driving electrodes of bare platinum	Pages 37-38 in paragraphs [0136] – [0138]; Page 38, [0139], lines 9-12.
27	electrodes are integrated electrodes formed using an ink	Page 22, [0076]; Page 25, [0085], lines 1-2.
28, 50	silver/silver chloride coated electrode	Page 37, [0135], lines 5-6 together with Page 38, [0139], lines 1-3.
46	a substrate having a channel and at least two apertures…a cover bonded to the substrate enclosing the microchannel… and a driving electrode associated with … two reserviors	Figure 1; Page 30, [0106].
47	electrophoretic separation medium within said channel	Page 9, [0010], lines 4-7; Page 37, [0135], lines 5-8.
48, 52, 53	two electrodes have surfaces comprising silver and silver chloride	
49	integrated electrodes adhered to the surface of said substrate or said cover	Pages 19-20, [0067].
51	used at least two times	Page 38, [0139], lines 8-9.
53	a microfluidic device comprising a substrate and a cover…having at least two electrodes … associated with two reservoirs	Figure 1; Page 30, [0106].
53	introducing a sample…into the device	Page 32, [0112], lines 6-7.
53	field in the medium of at least 400 V/cm	Page 35, [0126], line 4.
54	field in said medium of at least 600 V/cm	Page 36, [0128], lines 4-9; Page 37, [0133], lines 6-10.
55	analytes are eTags	Page 35, [0126], lines 1-4.
56	analytes are DNA fragments	Page 31, [0109] and Pages 31-32, [0110].
57	product of an enzyme assay	Page 31, [0108].

No new matter has been added by the amendments. Reconsideration of the application is respectfully requested.

The Invention

The invention provides devices and methods for reducing the amount of bubbles formed at an electrode in a fluidic device during the operation of that device in electrokinetic applications. In these applications, generally a large electric field is imposed across a path, for example a field of tens or hundreds of volts per centimeter, or greater, by placing electrodes at either end of the path, connecting them to a voltage supply and imposing a potential difference between the electrodes. In addition to the field established in the medium between the electrodes, electron transfer reactions between the electrode and the medium (e.g. the solvent) are likely, due to the large potentials applied. Indeed, electrolysis of the solvent is typically observed, as evidenced by the formation of bubbles of oxygen at the anode and hydrogen at the cathode when the solvent is water.

In typical 'macroscale' devices, such as gel boxes (e.g. the electrophoresis systems of Owl Separation Systems, available through VWR Scientific), bubble formation at the electrodes due to electrolysis does not cause blockage of the path or the loss of electrical continuity and thus varying electric fields in the electrophoretic path. However, in microfluidic and capillary devices, where the dimensions of components can be of similar scale to the size of bubbles produced, such bubbles can cause blockage and thus cause the techniques to be irreproducible and unreliable.

A typical approach to solving such a problem might be to employ an electrode material that exhibits a large overpotential for the expected electrolysis reactions, e.g. one at which water is not readily reduced or oxidized. Carbon electrodes are a good candidate material, and one which was tested by inventors, as is disclosed in the application. However, surprisingly, silver/silver chloride-based electrodes were found (1) to be useful as a driving electrode, and furthermore found (2) to surpass the performance of carbon electrodes in the suppression of bubble formation.

Silver/silver chloride electrodes are typically used as either a reference electrode or as a counter electrode in low voltage/low current applications. See for example the catalog for Gwent Electronic Materials, a manufacturer of sensors and biosensors, posted at http://www.g-e-m.com/products/biosensors.html. Working electrodes are available in a variety of materials, including silver. However, silver/silver chloride compositions are only used for reference electrodes. The same use of electrodes is found in the sensor products of PalmSens (see www.palmsens.com).

In contrast noble metals, such as gold, platinum, palladium, nickel, iridium, copper, silver, or other metals and carbon are well known as inert electrodes and as such used for high voltage/high current applications. An example application would be electrophoresis. To Applicant's knowledge, all commercially available instruments for capillary electrophoresis, gel

electrophoresis and the like are made with metal electrodes (See, for example systems from Owl Separation Systems, Applied Biosystems, Amersham, etc.).

In fabricating novel microfluidic devices with integrated electronic components, one would likely try to incorporate the noble metals or other well-known electrode materials (e.g. carbon) in an appropriate manner, drawing upon the many years of experience gained with printed circuit board fabrication. However, in the subject invention, the finding that silver/silver chloride electrodes could be used in a high voltage application, as a driving electrode in an electrokinetic device, was unexpected. Futhermore, that the suppression of bubble formation observed was better than any other material tested, was also unexpected.

Rejections Under 35 U.S.C. 112

The Examiner rejected claims 18, 21, 22 and 26-30 under 35 U.S.C. 112, second paragraph as being indefinite for failing to distinctly claim the subject matter. Applicants respectfully disagree with this rejection, particularly in view of the amendments.

The Examiner's comments are directed specifically at claims 18, 21, 22 and 26. Of these, claim 21 has been canceled. Claim 18 has been amended as suggested by the Examiner and now properly recites an "ink pattern". Claim 22 has been amended to have proper Markush language. Claim 26 has been amended such that an indefinite use of the term "reduces" is not recited.

In view of these amendments, Applicants respectfully request that the above rejection be withdrawn.

Rejections Under 35 U.S.C. 103

The Examiner rejected claims 1-45 as being unpatentable over U.S. Patent 6,375,871 to Bentsen et al., because the disclosure teaches the limitations of the subject claims, such as a cover, a substrate, a fluid reservoir, a microchannel and a conductive circuit trace, and assembles them in a device similar to that claimed in the subject invention. Furthermore, the Examiner asserts that bubble formation would inherently be reduced in a device of Bentsen et al, particularly one having a 'silver-filled ink trace'. Applicants note that the disclosure of Bentsen includes, "electrically conductive traces (e.g. traces made from nickel, gold, platinum, palladium, copper, conductive silver-filled inks, or conductive carbon-filled inks)" (Column 11, lines 1-4) as the materials indicated for forming microelectronic elements. There is no specific disclosure of silver/silver

chloride inks or materials. Silver-filled inks are commonly used and readily available from innumberable commercial sources and have properties and performance characteristics similar to the other electrode materials listed by Bentsen, thus it is most reasonable to take the disclosure at face value—that being an ink containing only silver. A silver/silver chloride electrode, as noted above, however is functionally different from the metal electrodes listed by Bentsen and would not be expected to be interchangeable.

Bentsen does not suggest using silver/silver chloride, nor does Bentsen's disclosure provide a motivation for choosing one material over another in fabricating an electrode because there is no recognition of the need for bubble reduction in electrokinetic applications. Bentsen is silent on the issue of electrode material choice for a particular application, and the materials presented vary greatly in their suitability for the electrokinetic applications claimed in the subject invention. For example, as disclosed by Applicant, platinum electrodes are unsuitable and yet carbon-based electrodes are acceptable, while silver/silver chloride, not disclosed by Bentsen, is the best choice.

In view of the above, and the amendments to the claims introducing the limitation of using silver/silver chloride electrodes, Applicants respectfully request that the rejection in view of Bentsen be withdrawn.

The Examiner also rejected claims 1-45 as being unpatentable, separately, over U.S. Patent 6,103,199 to Bjornson et al., U.S. Patent 6,623,860 to Hu et al, U.S. Patent 6,284,113 to Bjornson et al. and U.S. Patent Application Publication No. 2002/0092767 of Bjornson et al., because each disclosure teaches the claimed microfluidic device wherein the electrodes can be prepared from, e.g. conductive ink. The Examiner further asserts that bubble formation would inherently be reduced in any of these devices.

Applicants note that Bjornson ('199) teaches forming electrodes from "conductive materials such as platinum, gold, carbon fibers and the like" (Column 23, lines 44-45), "palladium" (Column 23, line 49), or "carbon paste, conductive ink" (Column 23, lines 57-58). Hu teaches forming electronic circuitry with "conducting inks, ... deposited metal thin films etc." (Column 8, lines 59-61). Bjornson ('113) teaches the "aperture...may be formed from, or the inner surface thereof coated with, an electroconductive material. The apertures and/or protrusions may be coated with ... conductive inks, insert molding of conductive material such as stainless steel and so forth" (Column 11, lines 29-35). Also, Bjornson ('113) provides the same disclosure as Bjornson ('199) of e.g. gold, platinum, carbon fibers, paste, conductive ink, etc. in Column 20, lines 26-45.

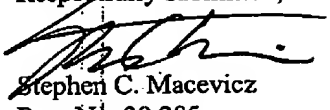
Finally, Bjornson ('767) discloses the same information as Bjornson ('199) in paragraph 0057. There is no mention of silver or even silver/silver chloride in any of the disclosures.

None of the references suggest using silver/silver chloride, nor does any disclosure provide a motivation for choosing one material over another in fabricating an electrode because there is no recognition of the need for bubble reduction in electrokinetic applications. The references are silent on the issue of electrode material choice for a particular application, and the materials presented vary greatly in their suitability for the electrokinetic applications claimed in the subject invention. For example, as disclosed by Applicant, platinum electrodes are unsuitable and yet carbon-based electrodes are acceptable, while silver/silver chloride, not disclosed in any reference, is the best choice.

In view of the above, and the amendments to the claims introducing the limitation of using silver/silver chloride electrodes, Applicants assert that the claimed invention is not obvious in view of the teachings of any of the references, and therefore respectfully request that these rejections also be withdrawn.

For the above reasons, Applicants submit that any basis for rejection has been overcome by amendment and respectfully request that the rejections be withdrawn, and that the claims be allowed and the application quickly passed to issue.

Respectfully submitted,



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